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West Virginia as a Poultry State

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West Virginia As a Poultry State

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Young Stock at Meal Time

West Virginia as a Poultry State

As a number of the poultry bulletins of this Station are now out of print it has seemed desirable to republish the salient features of these bulletins, together with such other advice gained from the experiments conducted at this Station as will be particularly helpful to the poultry keepers of the State. Also an effort has been made to point out some of the manifest advantages of West Virginia from the standpoint of the poultryman.

Poultry keeping can be engaged in successfully even under unfavorable conditions, but for the greatest success the various factors of climate, soil, nearness to good markets, and general freedom from serious diseases must each and all be such that fowls can be kept healthy and productive at a minimum expense and the products marketed to the best possible advantage.

West Virginia may well be termed the Poultryman's Paradise, for in respect to the natural conditions favorable to the industry little remains to be desired.

Climate and Topography of West Virginia.

West Virginia is a region of hills and valleys and mountains, with countless coves so sheltered from storm and wind that fowls may enjoy free and unrestricted range practically every day in the year. In these sheltered locations, too, the grass begins to grow early in the spring and remains tender and green until late in the fall, and in connection with a mild and agreeable climate, this induces the fowls to live an outdoor life,, with its consequent health, vigor and prolificacy. Fowls are more comfortable, more healthy and lay better when raised in a sheltered location protected from the wind.

The climate, too, of West Virginia is almost ideal for poultry, as the winters are neither so long and cold as further north nor the summers so hot and enervating as further south. The average annual mean temperature of the State is 52.3 degrees F. The mean temperature varies considerably in different sections, due to differences in altitude, which ranges from 280 feet above sea level at Harpers Ferry to a maximum of 4,860 feet, the height of Spruce Knob in Pendleton county. The actual range of latitude is 3½ degrees, from 37 degrees 10 minutes to 40 degrees 40 minutes, which gives a range of temperature of 3½ degrees, but the range of altitude being so great, from 280 to 4,860 feet, gives a range of temperature equal to a range of latitude of 10 or 15 degrees. In other words, the vegetation as well as the climate is such as may be found from the southern part of Virginia to Canada.

Soils.

The success or failure of any poultry enterprise depends to a large extent upon the character of the soil upon which the poultry plant is located, for if the soil is too heavy and tenacious there is a tendency for disease germs to accumulate to such an extent that after a time the fowls become unthrifty and unprofitable. Soil contamination with its consequent deleterious effects can be avoided to a certain extent by employing colony houses so that the fowls can be moved to a fresh piece of ground each year. Practically all of the upland soils of West Virginia are so well drained, however, that little trouble is experienced from soil contamination where ordinary methods of cleanliness are employed. Not only are the soils of West Virginia well adapted to poultry keeping in this respect, but land can still be purchased very cheaply even close to rapidly growing manufacturing towns and cities. The State, as a whole, is as yet somewhat sparsely populated.

Practically all soils adapted to fruit culture are adapted to poultry, for the reason that both require well drained soils. The production of fruit and poultry, too, may be made to go hand in hand, the trees furnishing shade so necessary for the comfort of the fowls during summer, and the poultry in return picking up many a noxious insect which might destroy valuable fruit, and gradually enriching the soil of the orchard by their droppings. The work of producing fruit and poultry can be so arranged that the slack period in the care and management of the flock will come when one is busiest with the fruit. Thus practically a double income may be obtained from the same area of land, each branch of the work helping the other.

Chert Soil Near Keyser, W. Va., Ideal for Fruit and Poultry.

Markets.

West Virginia is splendidly located in respect to markets. New York, the second largest city in size in the world, and the first city in the world in respect to the consumption of high-grade poultry products, is only 282 miles by rail from the extreme eastern portion of West Virginia, and Philadelphia, Baltimore and Washington are considerably nearer. Pittsburgh is less than 100 miles from the northern border, and Cincinnati, with its river transportation, is not so very much further from the southwestern portion of the State. All of these cities are near enough so that poultry products can be shipped by express and arrive in time to be sold and delivered to the consumer during the following day. Nearness to the great markets is a very important matter, especially in the case of poultry products, where freshness is one of the chief factors controlling the price.

For the small producer the home market, however, is the important one, and from that standpoint West Virginia is unexcelled, as the numerous mining and manufacturing towns that are springing up all over the State are increasing in population much faster than an increase is taking place in the production of poultry products. As a consequence of this condition a large part of the eggs and market poultry used in such cities as Clarksburg, Fairmont, Grafton, Morgantown, Elkins, Charleston and Parkersburg is shipped in from other states.

Poultry on the Farm.

The keeping of poultry is so widely scattered that we fail to gain a just conception of its real importance and magnitude.

The census of 1900 gave the value of the poultry products of the country for the year 1899 at $282,000,000, truly a vast sum. Five years later the value of the poultry products had practically doubled, amounting to $500,000,000. In 1907 there was a further increase of $100,000,000. That year the farm value of all corn produced in the United States was placed at $1,350,000,000, or not much more than double the value of the poultry products. Next in value to the corn crop stood the hay crop and cotton crop, each valued approximately at $650,-000,000, only $50,000,000 in excess of the value of the poultry products. Wheat, for that year, was valued at $100,000,000 less than the value of the poultry products. But the end is not yet! In 1909 the value of the poultry products had advanced another $100,000,000, and it is confidently expected that for the current year of 1911 the value of the poultry products of this country will reach the astounding sum of one billion dollars.

Now there may be many who read these figures who will consider them wild and fantastic, thinking it impossible for the humble hen to create values of such magnitude, but let us view the matter from another standpoint. How much would it cost to supply to each person in New York City two eggs apiece, or enough for one meal? According to the last census, there are in New York City 4,750,000 people, or practically 5,000,000 at the present time. If each of these people were given two eggs apiece it would require 10,000,000 eggs. If we assume that the average wholesale price for fresh eggs in New York City is 24 cents per dozen, or 2 cents each, the 10,000,000 eggs would cost $200,000. Now if this calculation be made to cover a year's time, and if to the value of the eggs the value of the market poultry be added, we are led to see that in eggs and market poultry we have an agricultural product of enormous money value. In 1909 there were received in New York City 4,256,320 cases of eggs, each holding 30 dozen, or a total of 1,532,275,200 eggs. In round numbers these eggs were worth $25,000,000 on the farm, and cost the consumers from 40 to 60 per cent more.

About 89 per cent of all farmers raise chickens, and eggs may be said to be almost a universal food as well as one having a high nutritive value. The production of eggs is steadily growing, but the demand is growing faster than the supply, consequently the price of eggs is going up. In 1899 the farm price was 11.15 cents per dozen as an average for the United States, while in 1909 the average was 19.7 cents.

What is to be the future of this great industry? Are the poultry products to be produced on enormous poultry plants where fowls are kept by the tens of thousands, or are the farm flocks to produce the great bulk of the eggs and market poultry as at present? There is only one answer to this question. We shall continue to produce the bulk of the poultry products upon the farm, and for these reasons:

In the first place the principal item of expense in keeping fowls is for the feed. The farmer has cheap feed. The grain on the farm is cheaper than after transportation and commissions have been added to it. Therefore under all conditions and in all cases the farmer has the advantage of cheap feed. The farmer, too, has the decided advantage of cheap labor. The fowls on the farm are taken care of largely by the children, the boys and girls that are growing up on the farm, and so the farmer is not confronted with the labor problem. Then too, the farmer's fowls have free range. They pick up a considerable portion of their food from waste grain, from table scraps, skim milk and from other things that otherwise would either go to waste or would not be utilized to such good advantage. And when the fowls are raised under free range conditions they have a tendency to be more vigorous and productive than where thousands of fowls are kept together, and where the soil frequently becomes impregnated with disease germs which so reduce the vitality of the fowls that they are no longer profitable.

How to Make Farm Poultry More Profitable.

Now inasmuch as the farmer is to continue to be the primary poultry producer of the country, what should the farmers of West Virginia do to increase the profit which they should derive from their fowls?

Keep More Fowls.

In the first place the farmers of West Virginia should keep more fowls. According to the last census 89,293 farms, or 93.1 per cent of all farms in the State, reported fowls. The total number of fowls on farms is given at 3,310,155. This does not include the fowls in towns, villages, and cities which were not enumerated. About seven per cent then of our farms have no poultry of any kind, and the farm reporting poultry, have on an average, only 37 fowls per farm flock. This is entirely too small a number of fowls to keep on a farm. With better local markets and no better natural advantages Ohio has 68 fowls per farm, Pennsylvania 62 fowls per farm, and Maryland 63. We can double the number of fowls without materially adding to the cost of labor necessary to care for them, and without materially adding to the cost for the necessary buildings. In this way and at one bound we can double the net income from the poultry in the State. Fowls kept with a reasonable degree of intelligence should give a net profit after paying for the feed, labor, interest on the investment. etc., of $1 per head. Now if we can double the number of fowls in our State we can increase the net revenue by something over $3,000,000, and we can do this next year if we would only get busy.

In this connection the following summary of poultry statistics for West Virginia from the Census Bureau is of interest:

Rolling Land with Sheltered Coves, Greenbrier County, W. Va., near Lewisburg.

Poultry Statistics.

The summary on poultry shows that the total number of farms reporting the different kinds in 1910 was 89,293, the total number of fowls being 3,310,155 and the total value $1,629,000.

Of the total number of farms reporting poultry, 89,293, nearly all, or 89,099, reported chickens, numbering 3,106,907, valued at $1,436,000; 18,762 reported turkeys, numbering 72,-752, valued at $124,600; 10,447 reported geese numbering 72,972, valued at $43,800; 6,776 reported ducks, numbering 35,-576, valued at $16,900; 3,486 reported guinea fowls, numbering 14,148, valued at $5,300; 941 reported pigeons, numbering 7,698, valued at $2,000, and 21 reported peafowls, numbering 102, valued at $235.

Of the whole number of farms in the State, those returning chickens formed 92.9 per cent; turkeys, 19.6 per cent; geese, 10.9 per cent; ducks, 7.1 per cent; guinea fowls, 3.6 per cent, and pigeons, 1 per cent. The reported increase in the value of poultry on West Virginia farms in the ten years, 1900 to 1910, was 69 per cent; the increase in total number of fowls 8.4 per cent. The number of farms reporting poultry increased 4,252, and the number of fowls per farm reporting increased from 35 to 37.

Comparative Summary. Poultry: 1910 and 1900.

	1910 (April 15)				1900 (June 1)
	Farms Reporting				
	Number	Per cent of all Farms	Number of Fowls	Value	Number of Fowls
Total	89,293	93.1	3,310.155	$1.628,700	3,053,071
Chickens	89,099	82.9	3,106,907	1,435,969	2,759,585
Turkeys	18,762	19.6	72,752	124,550	105,265
Ducks	6.776	7.1	35,576	16,854	58,273
Geese	10,447	10.9	72,972	43,802	129,948
Guinea fowls.......	3,486	3.6	14,148	5,325	(1)
Pigeons	941	1 0	7,698	1,965	(2)
Peafowls	21	(3)	102	235	(2)

(1) Included with chickens. (2) Not reported. (3) Less than one-tenth per cent.

Keep Younger Fowls.

Not only should the farmers of West Virginia keep more fowls, but they should keep younger fowls. On the farm, fowls of all ages run together. There is no system about keeping track of the age of the birds. When a chicken is caught for market or for the Sunday dinner, it is usually the first one that the farmer gets hold of. This is not the way to keep up a profitable farm flock. The younger the fowl, the more productive. The most profitable period in the history of a fowl is the first or pullet year, as one should get not only a high egg production, but also a considerable increase in live weight. In general an old hen is a poor layer. There should be some system by which a record of the age of the fowls can be kept. This can be done very easily, either by punching a hole in the web of the foot while the chick is still small, or by clipping off a toe when the chickens are removed from the nest or incubator. In carrying out the latter method the toe nail is cut off where it joins the toe, the shears being held in a slanting direction so as to remove the cartilege or root of the nail. If the toe nail is properly clipped off it marks the chick for life; and then the farmer when culling over his flock, just before they begin to moult in the fall, can select the oldest and leave the young and profitable ones.

Feed Better.

Another thing that the West Virginia farmer should do is to feed his fowls more intelligently. On the average farm, corn is the stand-by. On many farms corn is practically the only material that is used. That is entirely wrong. For the purpose of producing eggs, quite a large amount of nitrogenous material is required. The egg itself is a highly nitrogenous body, the white being almost pure albumen. Corn is too carbonaceous. It contains too much starch and oil. There is not enough protein present in it. Corn should be used as the foundation of the ration, but it should not be used to excess. Balance the ration with some nitrogenous feeding stuff. If skim milk can be had, there is nothing better. Let it sour, and either use it to moisten the ground feed or place it in pans and let the fowls help themselves. If skim milk is not available, it will pay to buy beef scrap. This consists of the odds and ends at the packing house. These are boiled and pressed so as to remove the excess of grease, then dried and ground. The scrap can be bought for about $3 per hundred pounds. The fowls can either be allowed free access to it or it can be mixed in the ground feed using about 10 per cent by weight.

Build Better Poultry Houses.

Not only should the farmers of West Virginia keep more and younger fowls and feed more intelligently; better houses should be provided. In this State it is not necessary to build expensive houses to keep out the cold, but the houses should be light, airy and dry in all kinds of weather, and the fowls should be free from draughts when on the perches at night. The houses should be kept clean and free from lice and mites. It is impossible to keep poultry profitably where lice and mites abound.

Keep Pure Bred Stock.

For best results, too, pure bred stock should be kept. The eggs from a mixed flock of fowls are of various colors and shapes, and the market fowls lack uniformity. Eggs to sell for the highest price in the big markets should be fresh, clean and of a uniform color and size. Only eggs from pure bred stock can possibly meet these requirements. The same principle is true in the case of market poultry. In the same way that a well bred steer is a more economical producer of beef than a scrub, so is a well bred fowl of the meat breeds a more economical producer of poultry flesh than a mongrel.

The Production and Sale of Market Eggs.

To start at the beginning, the hens should be provided with clean nests. A dirty egg is not only offensive in appearance, but as an egg shell is porous, the germs present in the filth gain access to the interior and the egg rots quickly. **Keep the eggs clean.**

The temperature at which an egg is kept influences the rate of decay. At summer temperature germs develop rapidly in egg substance, while at a low temperature the growth is very slow. In cold storage houses the temperature of the eggs is kept as close to the freezing point of the eggs as possible, so as to restrict germ development. **Keep the eggs cold.**

A fertile egg begins to develop into a chick even before it is laid, and this growth continues unless the egg is cooled below 68 degrees F. At 68 degrees F. the growth of the germ is barely perceptable, the germ soon dies and the egg rots, while at 103 degrees the growth of the chick is rapid. Hens lay as well when there is no cock kept with them. Hence sell all surplus cocks immediately after the breeding season. **Produce infertile eggs.**

An egg is never more valuable for eating purposes than the day it is laid. As time passes it gradually deteriorates

Well Drained Orchard Soil. Berkeley County, W. Va. Splendidly Adapted to Poultry.

until finally it becomes rotten and worthless Statistics collected by the Department of Agriculture indicate that of the marketed eggs in the United States 7.8 per cent are rotten and a total loss, and a much larger percentage stale and comparatively worthless. This loss is due largely to the time elapsing before the egg is delivered to the consumer. **Deliver the eggs to the consumer promptly.**

Co-operative Marketing of Eggs.

Some of the advantages of the farm flock have been pointed out. What are the disadvantages as compared with the large poultry plant? It would seem that the principal disadvantage in the production of eggs or market poultry on the farm is in respect to marketing the products. A farmer with a few fowls cannot gain and cannot retain a first-class market for his eggs. Take for example a club or hotel. They require fresh eggs in October, November and December, just the same as they do in April, May and June. The farm flock is usually on a vacation in the fall and early winter unless early pullets are on hand to take up the work of egg production. Usually too, the farmer does not produce eggs enough so as to get in touch with a first-class line of trade. This matter of marketing, however, could be easily remedied. Let the farmers in one community get together and appoint one of their number a selling agent, whose duty is to grade, candle, pack and sell the eggs produced by the members of the little co-operative association. Let the eggs be brought together at least three times per week in the warm season, and at least once per week during winter. With this arrangement the eggs from five, six, or a dozen farmers can be sold to just as good advantage as the eggs of a poultryman who makes egg-production his specialty. In those sections where cheese factories or creameries are in operation the cheese-maker or butter-maker frequently acts as the selling agent and the system possesses such merit that it is being rapidly and widely adopted.

Egg Production.

For the average West Virginia farmer egg production is the most profitable branch of the poultry industry. A flock of hens kept upon a farm in a fairly intelligent manner should average to lay at least ten dozen eggs per hen per year. These are worth at least 20 cents per dozen or $2. The chief expense in keeping fowls is for the feed. This seldom, if ever, should cost more than $1 per hen per year, and if the farmer produces the feed it should cost considerable less. There remains then

Open-Front Laying House. Front View. Built on the "Continuous House" Plan.

in excess of the cost for feed $1 per hen per year, which is practically clear profit. What other branch of agriculture can a West Virginia farmer engage in that will yield approximately 100 per cent per year on the money invested? There are certain things, however, that must be kept in mind and practiced before a profit of $1 or more per hen per year can be obtained.

Good Layers.

The advice is generally given to select an egg breed for egg production, but on the average farm this advice cannot be carried out very well, as the principal egg breeds, Leghorns and Minorcas, are poor mothers and can scarcely be kept to good advantage unless incubators and brooders are employed in raising the chickens. Consequently a majority of farmers are forced to keep a general purpose breed. Of these the Barred Plymoth Rock, the Wyandottes, the Rhode Island Reds and the Orpingtons are all deservedly popular.

Far too many flocks of mixed fowls or mongrels are kept. These are less profitable than the pure breeds on account of the greater uniformity of the eggs and market poultry produced by the pure bred fowls. Eggs uniform in color and size are worth 2 or 3 cents more per dozen in the big markets than the white and brown eggs mixed indiscriminately together. This premium paid for uniformity is in itself a good profit. The same principle holds true when market poultry is disposed of in any considerable quantity. Then, too, a farmer with a good flock of pure bred fowls can almost always sell some eggs for hatching at a considerable increase over the ordinary market price for eggs for eating purposes, and in the fall many of the surplus cockerels can be sold to good advantage for breeders.

Natural vs. Artificial Methods of Incubation and Brooding.

Where fowls are kept in large numbers, incubators and brooders are a necessity, but where a farmer keeps only 100 or 200 fowls it is a very debatable question whether it will pay to procure the equipment necessary to raise the chickens by artificial means. As a general proposition hen raised chicks are more vigorous than those raised artificially. This is particularly true when the incubators and brooders are operated by beginners or by farmers whose others duties prevent the proper amount of attention being given to this work.

For raising chickens on a farm, the methods used by Mr. Almy, of Triverton Four Corners, Rhode Island, are well adapted. All hatching and brooding is done by hens, as the hens know better than the average farmer how to bring up chickens. Several hens are set at the same time, and when the hatch comes off, the chicks are distributed so that each hen receives a certain number. This number depends to a certain extent upon the season of the year, the later in the spring the more chicks a hen can care for. The hen with the chickens is then placed in a little coop about three feet square in which the hen remains until the chicks are old enough to wean. The front of the coop consists of a window sash containing six panes of glass usually about 10x12 inches in size. The sash can be moved so as to allow the chicks to run out of the coop and the opening can be adjusted easily to the chickens as they grow larger. The glass in the front of the little coop keeps the interior well lighted and prevents the development of disease germs during the somewhat long confinement of the mother hen. These little coops are placed in rows in a field so that the chickens may be fed and cared for easily. The chickens are raised on the same ground in succession only two years, at the longest, as the field where the chicks have been raised is then plowed and planted to corn and the little coops taken elsewhere. The raising of the chickens on fresh ground so as to prevent infection from intestinal parasites of various kinds is one of the very important features of this method, and when to that is added the raising of the chicks by natural means so that the eggs during incubation are never overheated or chilled, or the little chicks injured by improper methods of brooding one can easily understand how it is that Mr. Almy has been able to continue in the poultry business on a somewhat large scale for several years with a general increase in the strength, vigor and productivity of his flock. For the professional poultryman incubators and brooders are a necessity, but there are many farmers who could imitate Mr. Almy's methods to good advantage. Take the money that would necessarily be spent for incubators and brooders, if artificial methods were used, and fix up a good place for the broody hens so that they can be kept separate and apart from the laying flock, and then give the hen and her chickens as much time and attention as would necessarily be given to the incubator and brooders, and in most cases when fall comes and it is time to place the pullets in winter quarters there will be more of them and they will be larger and healthier than though artificial methods were used. There is no royal road to wealth in the poultry business. Care and attention and intelligence are as necessary now as ever, and unless incubators and brooders are properly handled their purchase will prove to be an unprofitable investment for the farmer.

The hen that lays is the hen that pays, and a hen lays best when provided with a suitable house properly located. What is a good type of laying house for the West Virginia farmer? In my judgment the open front house in some form or other and modified to meet individual requirements and conditions is most likely to meet the conditions of cheapness, durability and efficiency.

The open front house is characterized by having one end entirely open, or covered with wire netting so as to keep out stray animals. As usually constructed this house is 24 feet deep and 16 feet wide, and is 5 feet high in front and 6 feet in the rear. The roof is of unequal span, the peak being located two-thirds of the distance from the front to the rear, and having an elevation above the floor of 10½ feet.

The perches are on a level with the front opening. In winter when the fowls have gone to roost the warm air resulting from their presence tends to collect in the upper portion of the house maintaining a comfortable temperature even in severe weather. Last winter with its zero temperatures the combs of S. C. White Leghorn hens were not frozen even when the front of the house remained constantly open. In poultry houses having a shed roof the warm air constantly flows away from the fowls, when they are on the perches, thus making the shed roof type of house somewhat colder for the fowls at night.

In order to keep the house cool during the warm season two doors are provided in the rear wall of each section of the building, opening underneath the nest boxes. When these doors are open, as in summer, the wind has unobstructed passage through the house and the fowls when on the perches remain comfortable even on very sultry nights.

This house has been in use for two years and seems to be well adapted to West Virginia conditions. It should face the south or southeast, and if a wind break is provided opposite the open side so much the better.

One of the advantages of this house is that the fowls always have plenty of fresh air and consequently remain healthier than where they are compelled to breathe impure air too often found in poultry houses. The free circulation of air, too, prevents any condensation of moisture on the walls of the building during frosty weather, and the litter on the floor constantly remains crisp and dry. Fowls remain healthier in a cold dry house than in a warm damp one.

End and Rear View, Showing Two of the Ventilating Shutters Open. Open-Front House.

Feeding for Egg Production.

It should be understood at the outset that the food that laying hens receive is only one of the factors which may affect the production of eggs. We all know that fowls, in order to lay well, should be of the right age, neither too old nor yet too young; they should be kept neither too cold nor yet too hot; and that they should be healthy and free from lice and mites or other external or internal parasites. We know that some breeds lay better than others, and that some individuals and strains lay better than certain other individuals and strains of the same breed. We know that overcrowding, overfeeding on certain foods, too scanty feeding, lack of exercise, and unsanitary quarters have a tendency to decrease the egg production. We know that when fowls are frightened or frequently disturbed or placed amidst strange or unusual surroundings that the egg production is materially restricted; also that a lack of constitutional vigor tends to prevent a heaping up of the egg basket.

Sometimes it would seem that, relatively, too much attention is given to the subject of feeding and too little to the other factors which may have as great or even a greater effect upon the egg yield, but it must be admitted that the food that fowls receive is usually under definite control, while some of the other factors are matters of heredity, environment or the weather, which can be controlled only indirectly or not at all.

Egg production depends upon the activity of the ovaries, and this activity, in turn, at least to a large extent, depends upon the physical vigor of the individual. Heavy egg production, then, is principally a problem of how to maintain laying hens in a high state of health, and the question before us today is how to feed in order to accomplish this purpose, but it should not be forgotten that constitutional vigor is as much a matter of fresh air, exercise and inherited stamina as it is a matter of food.

A hen requires food in order to furnish energy to carry on the various activities of the body and to keep the body warm; to build up the tissues and organs and keep them in repair and to supply material from which eggs can be elaborated. For these various purposes different classes of nutrients are demanded, a brief discussion of which may be of interest.

Carbohydrates.

The heat and energy required by a fowl are derived mainly from the fat and a number of other carbonaceous materials in

Interior View of Open-Front House Showing Opening to Nest Boxes Underneath the Perches.

the food, termed carbohydrates, which include starch, sugar, cellulose and other materials of the same general nature. For most purposes it is desirable to consider the carbonaceous materials of a ration collectively, and as the fat has about two and one-fourth times as much heating value as an equal amount of carbohydrates, it is customary to multiply the amount of fat in the ration by two and one-fourth and add it to the other carbohydrates so as to arrive at the total amount of effective carbonaceous material in the ration.

Protein.

The organic part of the bones, the tendons, the internal organs and the muscles in the body of a hen are derived from the nitrogenous constituents of the food commonly termed protein. Wheat gluten and white of egg are examples of protein.

Ash.

A fowl would not develop or lay eggs, however, if supplied with protein, carbohydrates and fat. Ash constituents are required to give substance to the bones and to a certain extent to enter into the complex composition of the various organs, and in the case of the laying hen to form the shells of the eggs.

Three Classes of Nutrients.

In feeding laying hens, then, there are three classes of nutrients which we must keep in mind in order that the fowl may be nourished properly: protein to build up and keep in repair the various organs and muscular system of the fowl and furnish material for the formation particularly, of the white of the egg; carbohydrates and fat to furnish heat and energy and to supply a considerable amount of fat which enters into the composition of the yolk of the egg, and finally ash constituents for the formation of the bones, egg shells, and to enter more or less into the structure of all the various organs and tissues of the body. Nor should we neglect to mention water as more than one-half of the weight of the fowl, or an egg, consists of this material.

Composition of Fowl and Egg.

In this connection it is of interest to examine into the ralative proportion in which nitrogenous and carbonaceous matter enter into the composition of the body of a fowl, and into the composition of an egg, for a knowledge of this proportion gives us an insight into the reason why certain grains or by-products give poor results when fed alone or in certain combinations, but which give good results when mixed together or fed in certain other combinations. Now, according to analysis, the body of a hen contains, in round numbers, 55 per cent water, 3.8 per cent ash constituents, 21 per cent protein and 17 per cent fat, and a fresh egg contains 65 per cent water, 12 per cent ash, 11 per cent protein and 9 per cent fat. If we now multiply the percentage of fat in both instances by two and one-fourth so as to reduce the fat to the same thermal equivalent as a carbohydrate, and then divide the products thus obtained by the respective percentages of protein in the body of a hen and in an egg, we find, speaking generally, and in round numbers, that there is one part of protein to two parts of carbohydrates expressed as though present in the form of a carbohydrate, or in other words, the nutritive ratio of the body of a hen and of an egg is as 1 to 2.

If we now examine the composition of one of the grains commonly used in feeding poultry, namely corn, we find that instead of one part of protein to two parts of carbonaceous material, as in a fowl or in an egg, there is only one part of protein to ten parts of carbohydrates. Now, inasmuch as protein and carbonaceous materials enter into the composition of an egg in quite definite proportions it can be seen readily if a laying hen were fed wholly on corn there would be relatively too much carbonaceous material as compared with the protein, for the building up of the egg, this excess being about eight parts of carbonaceous materials for every part of protein changed into egg substance. It is true that some of this carbonaceous material would be used to keep the fowl warm and to furnish muscular energy, but there would be too much even for this purpose except during extremely cold weather, and this excess accumulating would in time make the fowl too fat, with a consequent loss of vigor. The outcome, then, would be, when feeding nothing but whole corn, that few eggs would be laid, because only a small amount of protein would be available for the formation of the eggs, and the excess of fatty matters would tend to clog the system, with a consequent reduction in the vigor of the fowl. It may be observed here properly that a hen must be moderately fat in order to lay. A ration consisting simply of corn would be deficient, too, in mineral matter, or ash, for the formation of the egg shell and for other purposes.

In order that the nutritive materials of the food can be used economically for the various purposes of the animal body it is customary to mix the feeding stuffs together in such a way that there is a just proportion or balance between the various nutrients. A ration thus compounded is said to be balanced, while a ration which contains a relatively large amount of carbonaceous materials is called a wide ration, and one which contains a relatively large amount of protein is called a narrow ration. The nutritive ratio of a ration is the proportion of digestible protein to digestible carbonaceous materials, and is found by multiplying the amount of fat by two and one-fourth, adding the product to the digestible carbohydrates and dividing the sum by the amount of digestible protein.

The following table, which will be valuable for reference, shows the composition and nutritive ratio of the more common materials used as poultry foods. The figures are taken principally from a table compiled by Professor Henry and published in a "Special Report on Diseases of Cattle and Cattle Feeding."

	Ash.	Crude Protein.	Carbohydrates.	Fat.	Nutritive Ratio.
Corn, Dent	1.5	7.0	63.4	3.9	1:10.3
Wheat, winter	1.8	9.2	55.9	1.8	1: 6.5
Barley	2.4	9.5	66.1	1.2	1: 7.2
Oats	3.0	9.1	44.7	4.1	1: 5.9
Buckwheat	2.0	7.7	49.2	1.8	1: 6.9
Peas	2.6	18.0	56.0	.9	1: 3.2
Soy Bean	...	29.6	17.7	15.9	1: 1.8
Cowpea	...	18.1	34.5	1.3	1: 2.1
Cornmeal, bolted	...	6.3	61.8	3.0	1:11.0
Wheat bran	5.8	12.6	44.1	2.9	1: 4.0
Wheat middlings	3.8	12.2	47.2	2.9	1: 4.4
Oatmeal	...	11.3	49.9	5.8	1: 5.5
Brewer's grains dried	...	16.2	35.5	5.3	1: 2.9
Gluten meal	.8	25.0	49.4	5.6	1: 2.5
Linseed meal	5.3	27.2	31.8	2.7	1: 1.4
Dried blood	4.7	59.1	....	2.3	1: 0.1
Meat scraps	4.1	68.4	.3	13.5	1: 0.4
Skimmed milk	...	2.9	5.2	.3	1: 2.0
Red clover hay	6.2	6.5	34.9	1.6	1: 5.9
Mangels	...	1.1	4.8	....	1: 4.4
Entire egg	12.2	11.4	....	8.9	1: 1.8
Rutabagas	...	.9	7.1	....	1: 8.9
Hen, entire fowl	3.8	21.6	....	17.0	1: 1.7
Pullet, entire fowl	3.4	21.2	....	18.0	1: 1.9

As compared with the composition of an egg, most of the grains commonly employed as poultry foods are too low in protein and ash, and care should be taken to supply these deficiencies by the use of beef scrap, ground fresh meat and bone or other materials of somewhat similar composition. Feeding stuffs which are rich in protein usually cost more than those rich in carbohydrates and fat, and if there is a lack of the latter constituents some of the protein may be used to furnish heat and energy, instead of carbohydrates. This would be expensive, to say nothing about the effect upon the health of the fowls of feeding a ration that is too narrow. There should be a just balance or proportion between these classes of compounds for best results, but our knowledge of the feeding of poultry is not thorough enough so that definite and exact advice can be given as to the relative proportion in which these classes of nutrients should be present for best results.

Wide and Narrow Rations.

Professor William P. Brooks, of the Massachusetts Experiment Station, has been studying this subject for a long time, and has carried out some thirty-six experiments in feeding wide and narrow rations. The nutritive ratios of the narrow rations have averaged in these experiments 1 to 4.4, or, in other words, they averaged about as nitrogenous as wheat middlings. On the other hand the wide rations had nutritive ratios averaging 1 to 5.97, which is about the same as the nutritive ratio of oats, which are somewhat more nitrogenous than wheat. In these experiments conclusive results were not obtained, as about one-half of the tests favored the wider rations and the other tests gave results in favor of the narrower rations, and it seems probable from the evident care with which these experiments have been carried out, and the results which were obtained, that the nutritive ratio of the ideally perfect ration is not far removed from the average of the nutritive ratios of the rations employed, or about one part of digestible protein to five or five and one-half parts of digestible carbohydrates. It is not believed, however, that the proportion between these two classes of nutrients should be fixed and definite for all cases and conditions, as it stands to reason that a pullet not fully grown should be fed on a ration somewhat richer in protein and ash than required by an old hen, and that fowls during very cold weather should receive a ration more carbonaceous than during warm weather.

Importance of Ash Constituents.

In feeding for egg production it is necessary not only to have the proportion of protein to carbohydrates approximately correct, but it is also essential to have the ash constituents of the ration sufficient in amount. There is nearly eight times as much ash in the dry substance of an egg as there is in corn or wheat, and this deficiency must be made good in some way. Wheat bran, oil meal, beef scrap and clover or alfalfa hay are all high in ash and can be used with profit in a ration for laying hens, and in most cases these feeding stuffs high in ash should be supplemented by the use of cracked oyster shells, limestone grit or granulated bone fed ad libitum.

Animal Versus Vegetable Protein.

Most of the earlier experiments performed to study the relative value of protein from animal and vegetable sources seemed to show that the protein of animal origin is more valuable than vegetable protein for growth and egg production, but it has been found that the apparent superiority of animal protein is due largely, if not entirely, to the fact that it is usually associated with a larger percentage of ash in the ration. As soon as the difference in ash content is overcome then protein from the two sources seems to have practically the same value. Professor Wheeler, of the Geneva Station, in speaking of his investigation says: "The experiments all point in one direction: toward the superiority of rations containing animal food over those made up of grain. In no case has the reverse of this proven true, and in nearly all the trials the difference has been most noticeable. When the lack of mineral matter in all grain ration, as compared with one containing animal meal, is supplied by bone ash, the difference disappears or favors the grain ration, so far as chicks and laying hens are concerned. That is, it is the small amount of ash in the grain ration which makes this ration inferior to one containing animal meal, rather than a difference in the protein. Something to supplement the ash-poor grains they must have, and it is simpler to give it in the natural form, combined with valuable protein and fats, than to burn out the organic matter and give the ash only."

Whatever may be the explanation, then, the fact remains that beef scrap, meat meal, ground meat and bone, or similar products of animal origin are practically indispensable. Sour skim milk, too, is very valuable addition to a ration for laying hens whenever it is available.

The Importance of Green Food.

In some experiments carried on at the West Virginia Station several years ago it was found that a liberal, as compared with a scanty supply of green food, increased the egg production by two dozen eggs per hen per year. For use in winter mangels or large stock beets are one of the most popular of green food materials, on account of their feeding value, and ease with which they may be grown. Cabbage is sometimes used, and clover or alfalfa hay are excellent substitutes. The hay may be cut into short lengths, steamed and fed in the

Rolling Land near Morgantown. Here the Conditions Necessary for Health and Vigor in Poultry Cannot be Excelled.

mash, or the material may be fed in the dry state, as the hens quickly learn to pick off the leaves, heads and more tender portions. Because hens readily eat the leaves and heads of clover and alfalfa hay is not a good reason for assuming, however, that foods rich in fibre are especially valuable for poultry. On the contrary, experiments indicate that of two rations otherwise equal the one lower in fiber is the better. In fact oats, barley and buckwheat, all of which are relatively rich in fiber, usually occupy a secondary place in poultry feeding.

Dry Mash As Compared With Moistened Mash.

The dry mash system of feeding consists, as it is well known, of keeping a mixture of dry ground grain in feed hoppers so as to be accessible to the fowls. The whole grain that is fed is usually scattered in the litter, so as to induce the fowls to take a certain amount of exercise. At the Maine Station, where this system of feeding has been carried out with success for several years, the practice is to scatter four quarts of corn per hundred fowls in the litter early in the morning; at 10 o'clock they are fed in the same way two quarts of wheat and two quarts of oats. This is all the regular feeding that is done. The dry meal mixture that is constantly available to the fowls is composed of 200 pounds wheat bran and 100 pounds each of cornmeal, middlings, gluten meal, or brewers' grains, linseed meal and beef scrap.

Experimental evidence is lacking to enable one to say whether this system of feeding hens is as good or better than the old system of feeding a moistened mash. That the old system of feeding, although it takes more time and requires somewhat more judgment on the part of the feeder, is a very satisfactory method to follow cannot be questioned.

I have before me the report of the egg-laying competition of 1907-08, held at the Agricultural College, Roseworthy, South Australia. In this competition seventy-five pens of fowls were entered. Each pen consisted of six females and one male. They were fed as follows: At 7 a. m. they received a mash of bran and pollard (middlings), one and one-half parts of pollard to one part of bran, mixed during the cold weather with soup to which cut vegetables and green stuff was added, together with a handful of salt. The mixture was fed hot, and in a crumbly condition. The quantity fed to each pen varied according to the appetite of the occupants. At noon green food was supplied during the cold weather, but when the warm weather set in this was withheld, as it soon dried up in the heat. Chaffed alfalfa, during the hot period, was mixed with the mash in the proportion of one-third by bulk. At 4:30 p. m. grain was fed to the birds in straw litter. During the winter maize and peas were used, but the principal grain was wheat. The grain in the scratching litter provided constant exercise and occupation for the birds. No green cut bone, spices, or other forcing foods were used, and the diet was well balanced, though simple in character. During the year there were consumed 331 bushels of wheat, 537 bushels of pollard or middlings, 430 bushels of bran, 950 bushels of meat meal. The amount of corn and peas fed is not given, but the amount fed was relatively small judging from the cost of these materials.

When fed in this way the banner pen, White Leghorns, laid during the year 1,531 eggs, or an average of 255 eggs per bird. The next highest pen, also White Leghorns, averaged 254 eggs per bird. Of the seventy-five competing pens thirty-four were White Leghorns, and it is of interest to observe, in respect to the influence of strain upon prolificacy, that, although the two foremost pens of White Leghorns led all of the other breeds by a considerable margin, yet there was a pen of White Leghorns in the sixty-eighth place with a record of only 141 eggs per fowl.

It is very doubtful whether an average of 255 eggs per bird in a pen containing six females could have been made through the use of the hopper system of feeding. I understand that our Department of Agriculture at Washington is making a study of this matter, and it is probable that at our next meeting we may have some definite information about this important subject.

In conclusion let me call your attention to the fact that the feeding of laying hens is a problem of a different nature than the fattening, for example, of a bunch of steers. In one case the food is digested, assimilated, and used to build up the bodily structures, and the principal things required are good feeding stuffs and a good digestive system. In the case of laying hens, however, not only must the digestive system be able to digest a large amount of relatively rich food, but the reproductive organs must be kept vigorously active, and in a most perfect condition, and this ideally perfect condition is not entirely a matter of food or methods of feeding.

In the early history of our country large families were the rule. Our ancestors were healthy, vigorous and good breeders. They were of necessity active men and women, for they had a continent to subdue with Indians, forests and wild beasts. It does not seem probable that their food was any more wholesome than that which we have today, but their families were larger, and it is my belief that herein lies an important principle which we should constantly keep in mind when dealing with poultry.

Raising Chickens Artificially.

Although it is believed that most farmers who raise from one hundred to two hundred chickens annually will do well to continue to raise hen-hatched chicks instead of purchasing and using incubators and brooders, yet as there is a wide-spread demand for information regarding the best methods of raising chickens artificially, the following discussion of the subject has been included in this bulletin. To a considerable extent this discussion is a reprint of bulletin 98, although certain portions have been rewritten so as to be in conformity with later experiments.

Although chicks have been raised by artificial means in Egypt, China and perhaps other warm countries almost from time immemorial, yet, in the temperate zones where the climate is not so favorable for this purpose, artificial incubation and brooding is practically a recent development. On account of this fact the art of raising chickens artificially has not been perfected so fully as is the case with most other branches of husbandry which have been engaged in for a much longer time.

During the past ten or twelve years from one thousand to three thousand chickens have been raised annually at this Station by artificial means and various experiments connected with this work have been performed. In this discussion it is planned to give, not so much the details of experiments, but rather the practical results as the outcome of all of them.

The Production of Eggs Suitable for Hatching.

In order to raise chickens successfully it is very essential to begin with eggs which will hatch well and produce strong vigorous chicks. If the germs are naturally weak no amount of attention and good care during the incubation of the eggs and the brooding of the chicks will make up for the original lack of vigor. In spite of all that can be done the hatch will be poor, and many of the chicks which do hatch will die. As one cannot determine by an examination of the unincubated egg whether the germ is strong or weak the only thing that can be done in practice is to select the breeding stock with such care and give it such attention that eggs suitable for hatching must of a necessity result.

Age of Breeding Stock.

Early hatched pullets lay better in winter, when eggs are high in price, than old hens, and as a consequence on many egg farms practically all of the older hens are disposed of each summer and their place is taken by pullets hatched during the preceding spring. While this undoubtedly is good policy from the standpoint of winter egg production, yet it has led in many cases into the practice of incubating the eggs of these pullets, during the following spring, when the fowls are practically one year old. Is it a good plan to use such eggs for hatching? Are the resulting chicks strong and hearty, and do they develop into as thrifty, vigorous individuals as though they were the offspring of more mature stock?

To throw light on this question eight experiments were carried out and the following summary gives the results of these tests:

	Old Hens.	Pullets.
Total number of eggs incubated less those cracked in turning	1094	871
Average weight of eggs per hundred	12.96 lbs.	11.19 lbs.
Total number of chicks	840	591
Per cent. hatched of eggs incubated	76.7	67.8
Average weight of chicks per hundred when removed from incubator	8.28 lbs.	7.12 lbs.
Average weight of chicks at second weighing, per hundred	29.56 lbs.	23.07 lbs.
Total number of recorded deaths	42	85
Per cent. of chicks which died	5	14.5

The results of this series of experiments clearly show that it is a matter of prime importance to have the breeding stock vigorous and of mature age. The eggs from the young fowls were smaller than the eggs from the older hens, and the chicks were smaller when they were hatched, grew more slowly, and more of them died from chick diseases than was the case with chicks hatched from eggs laid by the mature fowls.

Feeding Breeding Stock.

The fowls should be fed a ration containing in proper proportion the different food elements required. Green food, grit, pure water, pure air, and the opportunity to take exercise are all important. Whenever possible the breeding stock should be allowed unrestricted range, as this induces them to take plenty of exercise which tends to keep them healthy, and they are also able, to a certain extent, to balance their own rations by means of the bugs and worms which they secure.

In feeding it is important to feed neither too much nor too little, for one extreme is as bad as the other. If fed too much the fowls are apt to become sluggish and lazy, and the chickens which result will almost invariably be weak. On the other hand if the fowls are fed too scantily a large proportion of the eggs will be unfertile, and the chicks will not be as vigorous as they otherwise would. The fowls should be well fed but not overfed on a ration containing enough protein. This may be supplied by beef scrap, ground fresh meat and bone, skim milk, or some other substance of similar nature. With the small active breeds of fowls like the Leghorns mash may be fed with safety once per day, but with the meat breeds which have a tendency to become too fat it is usually best to feed mostly whole grain scattered in litter. The method of feeding Leghorns for the production of eggs suitable for hatching which has been adopted at this Station is as follows: In the morning whole grain consisting of equal parts by weight of corn, wheat and oats is scattered in the litter covering the floors of the poultry houses. This is fed at the rate of from 7 to 10 quarts per hundred fowls. In the evening mash is fed consisting of equal parts of corn meal, ground oats and wheat middlings to which is added ten per cent of beef scrap or meat meal. The mixture is moistened with skim milk or water, and fed at the rate of from 6 to 8 quarts per hundred fowls. If this is eaten up quickly and the fowls appear hungry more whole grain is scattered in the litter. Under this system of feeding and allowing one vigorous cock to ten or fifteen hens the eggs have uniformly run high in fertility, and the chicks have been strong and hearty. *It is a very bad plan to use eggs for incubation which have been produced by hens that have been fed heavily during the winter for egg production. Under these conditions the vigor of the hens, when spring comes, is apt to be reduced, and even though the eggs may hatch fairly well the chicks are apt to be weak and puny. The breeding stock must be vigorous in order to produce the right sort of eggs.*

Artificial Incubation.

The success or failure of artificial incubation depends largely upon the machine selected to do the work. Therefore great care should be exercised in making the selection. To be satisfactory a machine must be durable. There are many machines on the market which will hatch well when new but which are constructed so flimsily that in a short time they become worthless, and in this connection it should be remembered that an incubator which fails to give good hatches is worse than useless as each time that it is operated unsuccessfully the eggs are lost, the oil used is wasted, and the opportunity to make a profit from the chickens which should have been hatched is gone forever. Therefore, if artificial incubation is practiced it is wise to have good machines with which to do the work. Personally I am in favor of hot air machines because there is no water to bother with, no tanks to rust out and leak, or freeze and burst in cold weather when not in use.

The Location of the Incubator.

Although the modern incubator can be operated almost anywhere, yet to be most successful it should be located where the temperature is as uniform as possible. The advice has frequently been given to locate the incubator in the cellar. This advice is all right provided the cellar is clean, light and well ventilated. A close, dark, ill-smelling cellar is about the worst place imaginable for this purpose. A half-cellar, four feet in the ground and three feet above, is an ideal place in which to run an incubator. Such an arrangement admits of enough air and light, and affords a temperature uniform enough for all practical purposes. In operating an incubator in a dwelling house it is well to remember that many insurance policies do not provide for risks of this nature, although in reality there is scarcely any danger from fire if the incubator is given reasonable attention.

The Operation of the Incubator.

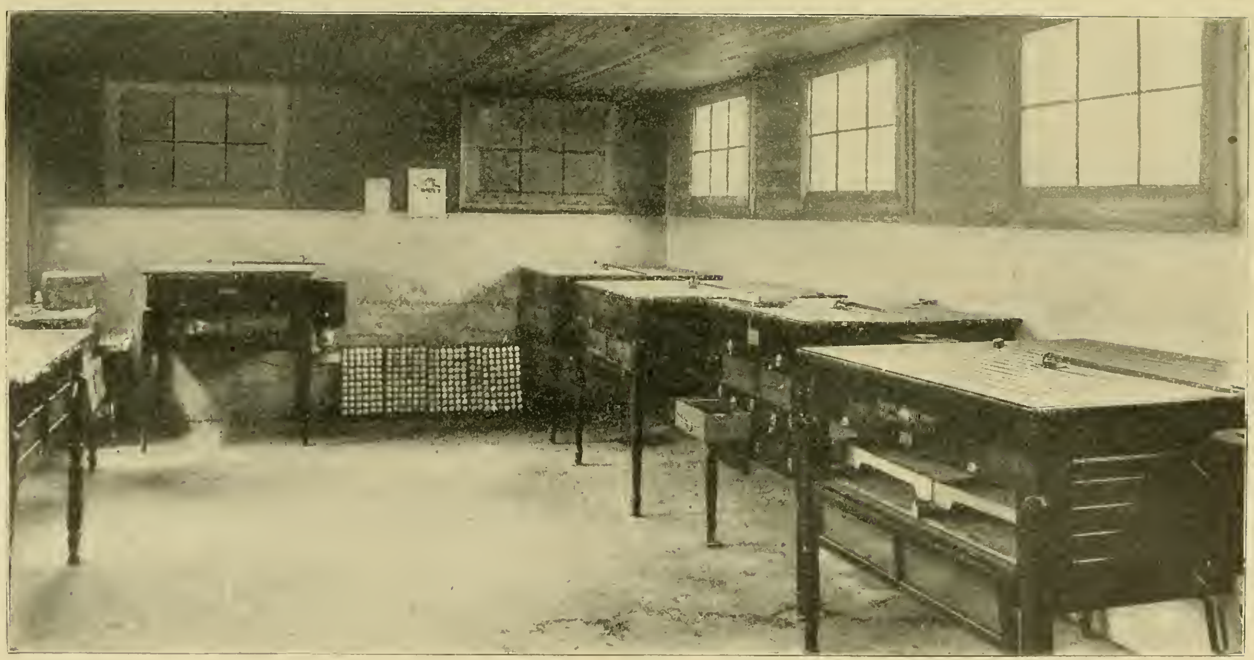
The machine should be set up carefully according to directions and the incubating chamber gradually brought to the proper temperature. The temperature which the thermometer should register depends somewhat upon its position in the incubating chamber. If the thermometer merely records the air temperature on a level with the tops of the eggs as they lay upon the trays, and is suspended near the center of the chamber then a temperature of 102½ will bring the chicks out promptly on the twenty-first day. The eggs should not be placed in the incubator until after the operator is able to maintain a fairly uniform temperature. Unless the regulator is properly adjusted to the right temperature and all the parts in good working order it is a very easy matter for the temperature to run too high and thus injure or totally destroy the hatch. The temperature should be maintained as uniform as possible. All violent fluctuations are unnatural and injurious. This is especially true of temperatures above the proper incubating temperature. Cooling the eggs a few degrees below the proper incubating temperature does no harm and in case the ventilation of the machine is not sufficient to supply the germs with enough oxygen this cooling may be necessary for a good hatch.

Ventilation and Moisture.

The ventilation of the machine is next in importance to the temperature. During their development the germs absorb oxygen and throw off carbon dioxide or carbonic acid gas as it is sometimes called. If the carbon dioxide is allowed to accumulate, or in other words, if the vitiated air is not replaced by pure air with sufficient rapidity, the germs will be weakened and those which are somewhat naturally weak will be killed. It is my impression that bowel trouble, and non-absorption of the contents of the yolk sack, two very common ailments of incubator chicks, are frequently caused by lack of fresh air in the incubating chamber during the hatch. For good results the eggs must be given plenty of fresh air. When this is overdone another trouble is encountered. The eggs lose too much moisture and the chicks dry fast to the shell, thus destroying many chicks and producing many cripples. On the other hand if the eggs do not lose enough moisture the chicks are weak and flabby and do not have sufficient room so that they are able to break their shells and thus make their escape. Between the two extremes of too much moisture and too little there is a medium where the moisture conditions are just right, and which when closely adhered to in practice gives best results. In bulletin No. 73 the loss in weight of eggs while being hatched by hens is discussed, and I quote as follows from that publication, which is now out of print:

"It is unnecessary to describe in detail the stages in the development of a chick. The chick, however, absorbs oxygen, and moisture and certain gases are thrown off through the shell. Under normal conditions the total amount of moisture and gases which have been thrown off at any particular time corresponds to that particular stage in the development of the chick, or in other words, when the egg is incubated under perfectly normal conditions the total loss in the weight of the egg corresponds, within certain limits, to the stage of development of the embryo."

"If the operator of an incubator knows how much a certain number of eggs have lost in weight since the beginning of the incubating period and compares this loss with the normal loss of the same number of eggs for the same length of



The Incubator Cellar.

time when incubated under hens, he will know definitely whether the eggs have decreased properly in weight. If they have lost too much, provided of course, that the temperature has been normal, they are drying up too rapidly, and either more moisture should be supplied, or the amount of ventilation should be reduced, but in reducing the circulation of air through the incubating chamber it must be remembered that pure air surrounding the eggs is just as important as a proper temperature; on the other hand, if the eggs are not losing weight as rapidly as they should they are either kept too moist, or they are not receiving the proper amount of ventilation, or perhaps they may be kept too moist and insufficiently ventilated also."

"The object of this bulletin is to furnish sufficient data to enable the operators of incubators to exercise a more intelligent supervision over the operation of their machines. A number of experiments have been performed to determine the normal loss in weight of eggs during incubation, and for this purpose the natural method of hatching has been employed. Eggs have been weighed, placed under broody hens in locations suitable for a perfect hatch, re-weighed on a chemical balance at suitable intervals, and the loss determined."

As a result of the studies detailed in bulletin No. 73, the following directions were issued covering the practical points involved:

Directions.

After placing the eggs upon the trays ready for the incubator set the trays upon a pair of scales reading to ounces and note the total weight of the eggs and trays. (The trays should be thoroughly dry). After a few days weigh again. Subtract this from the first weight. This will give the actual loss in weight of the eggs.

Example.—Suppose that you have 208 eggs on the trays; that the first weight with trays is 24 pounds 2 ounces; and that on the sixth day the weight is 23 pounds 6 ounces. Then the loss in weight is 12 ounces. Now look in the table for the loss in weight of 100 eggs for six days. This is 10 ounces. Ten ounces multiplied by 2.08 gives 20.8 ounces, which is the calculated loss for 208 eggs for six days. Therefore the eggs have not been losing weight as rapidly as they should, and the eggs should be given more ventilation or the incubator should be removed to a drier location. (It is assumed that the eggs are kept uniformly at the proper temperature). After the eggs have been tested for the infertile ones weigh again and proceed as before.

Rules.

If the eggs have *lost too much weight* give more moisture or less ventilation, but in reducing ventilation great care should be used, as pure air in the egg chamber is absolutely necessary.

If the eggs have *not lost enough weight* open the ventilators, or place the incubator in a drier place.

Table showing normal loss in weight of 100 eggs in ounces for the first nineteen days of incubation:

1	1.65	7	11.72	13	22.10
2	3.31	8	13.44	14	23.88
3	4.96	9	15.16	15	25.66
4	6.62	10	16.88	16	27.44
5	8.28	11	18.60	17	29.21
6	10.00	12	20.33	18	30.99
				19	32.77

Turning.

The eggs should be turned twice per day until the nineteenth day of the hatch. It is not necessary to turn each egg just half way over each time. This is unnatural and I think, to a certain extent injurious, and it is probably partially due to this fact that the extra-tray method of turning seldom gives as good satisfaction as hand turning. In turning eggs by hand on trays built like the Cyphers the eggs at the center of the trays are picked up and other eggs rolled into their place. The eggs taken from the center are then placed at the ends. This method possesses the advantage of systematically changing the relative position of the eggs upon the trays, thus equalizing the effect of any possible inequalities of temperature which may exist in the incubating chamber. This principle of overcoming the effect of any variation in temperature is further carried out by changing the trays from side to side at one turning, and at the next turning change them from end to end, and so on. When these things are done the chickens nearly all hatch at about the same time. A hatch which is long drawn out usually indicates that there are inequalities in the temperature of the incubating chamber which have not been overcome by changing the eggs about as indicated above.

Airing and Cooling Eggs During Incubation.

Eggs hatched under natural conditions are left unprotected when the broody hen leaves the nest in search of food. At such times the eggs become cool or even cold, and being freely exposed to the air the absorption of oxygen and the excretion of carbon dioxide is facilitated. In the popular mind this process of cooling and airing is associated with the development of strong vigorous chicks, and consequently it is not surprising to find many incubator manufacturers giving directions in regard to cooling and airing eggs during the process of incubation. There is, however, a general lack of specific instructions or advice as to how long to cool the eggs or how cold to allow them to become.

In the case of natural incubation it would seem that the process of cooling and airing is due to the necessity of the mother hen of obtaining food, and may have no connection whatever with normal incubation. Instead of being of benefit, the cooling of eggs during incubation may be detrimental, inasmuch as cooling the eggs tends to slow down the vital processes and delays the development of the embryos.

In the case of machines in which the ventilation is imperfect it is quite possible that the cooling and airing process may be of benefit by giving the embryos fresh air rather than through the cooling effect, although it must me admitted that merely the cooling of the eggs may be the means of giving the embryos an increased supply of oxygen, for, when an egg is cooled the heated air in the air cell contracts and a small amount of air is drawn in through the pores of the shell.

To throw light on this question five experiments were carried out and the following conclusions were drawn as the result of the tests.

In the first trial with the ventilators open and with an average maximum and minimum outside temperature of 80° and 54.7°, respectively, a better hatch was obtained, and the chicks were stronger when the eggs were not cooled.

In the second trial with closed ventilators, and with a low external temperature, the eggs not cooled hatched better and the chicks were stronger than was the case with the other treatment.

In tests 3, 4 and 5, conducted simultaneously, with closed ventilators, and a high outside temperature, the eggs not cooled hatched better than the cooled eggs in the two Cyphers incubators and not quite so well in the Prairie State. The chicks, however, from the cooled eggs were materially stronger than the others in all three hatches, as fewer of them died. This would seem to indicate that in warm weather when the circulation of air in the incubator tends to become sluggish, and especially with an insufficient opening of the ventilators, it may be advisable to air the eggs for a reasonable length of time for the purpose of giving the embryos a more adequate supply of oxygen.

Near Morgantown, W. Va. Sheltered Coves Where Poultry is Protected From Wind and Storm.

It is difficult to conceive of any valid reason for cooling eggs during incubation and thus slowing down the vital processes, and these experiments seem to indicate that the beneficial effects which unquestionably sometimes result from the process of cooling and airing are due to the airing, and that the cooling of eggs during the process of incubation below the proper incubating temperature, when considered by itself, is detrimental,

Testing.

The unfertile eggs and those with dead germs are usually tested out twice during the hatch. This is done so as to keep the air in the incubator as pure as possible, and when these eggs are used for feeding young chickens the more promptly they are removed after their condition can be determined by the egg tester the better.

Now, having started with eggs suitable for hatching; having kept them at the proper temperature; having turned them regularly twice each day; having given them sufficient fresh air for the germs to develop properly; and having regulated the moisture conditions just right, allowing the eggs neither to dry down too much nor to retain too much moisture, the chicks on the nineteenth day should begin their efforts to divest themselves of their shells and on the twenty-first day the incubator should be full of downy bright-eyed chicks anxiously awaiting their liberation.

Taking Off the Hatch.

After the eggs begin to pip they should be interfered with as little as possible. The front door should not be opened to see how the hatch is progressing, as this reduces the humidity of the air in the incubator and also lets cold air strike the chicks not yet dried off, both of which things are injurious. Close watch should be kept of the thermometer at this time and if the temperature tends to drop, due to the drying off of a large number of chicks, the lamp should be turned up higher for a time, or the regulator slightly adjusted. On the other hand it is frequently necessary when the weather is warm to remove the lamp entirely during the latter part of the hatch, the heat generated by the chickens being sufficient to keep up the temperature.

After the chicks hatch they tend to crowd towards the light, and it sometimes happens that those in the front part of the incubator become so hot by being crowded together that they pant. Impure air, also, may cause them to pant. Whether caused by too much heat or by impure air the panting of the chicks is unnatural and injurious, and should be stopped either by opening the ventilators so as to give more air; by reducing the temperature; or by removing some of the chicks to the brooder so as to give those remaining more room.

From the time the chick pips the shell until it is transferred to the brooder and has become hardened and accustomed to its new surroundings is a very critical time in its history, and mistakes made at this time are almost irreparable. If a cold draft of air strikes the chicks which are not dried off; if they are exposed to the cold air while being transferred to the brooder; if the brooder is too cold for them; or if, after being placed in the brooder, they wander outside and become chilled before they learn where to go to get warm, they will catch cold, inflammation of the lungs will result in many instances, and the chicks will die. Or if the chicks become overheated in the incubator, or are allowed to pant on account of the lack of sufficient fresh air, they are seriously weakened, and many of them will die before they are ten days old from bowel trouble. In fact, to obtain the best results almost constant supervision should be exercised during this trying period of the chick's life.

Brooding.

Temperature. In brooding chicks either in individual brooders or in brooder houses the main thing which must be watched is the temperature, for if the temperature is either too high or too low the results will be totally unsatisfactory even though all of the other conditions governing the health of the chicks are ideal. Chicks three or four days old are fairly hardy little creatures and can endure a considerable degree of cold provided that as soon as they become too cold they can quickly get warm again. But if they are forced to remain where the temperature is too low they catch cold very quickly, the lungs soon become inflamed, little nodules of light colored cheesy matter form in them and death results.

The temperature of the brooder or brooder house when the chicks are first transferred from the incubator should be practically as high as the temperature of the incubator from which the chicks have just been removed, or from 95 degrees to 100 degrees F. This temperature should be maintained for the first week, never allowing it to fall below 95 degrees. The second week the temperature should not be allowed to drop lower than 90 degrees. These temperatures refer to the air temperature taken on a level with the chicks. After the second week the temperature should be reduced gradually until the chicks are old enough and hardy enough to do without artificial heat. At no time should the chicks be uncomfortable either on account of too much cold or too much heat. If they are too cold they will huddle together, those on the inside of the bunch will become too warm and will pass to the outside where they become too cold again. Under these conditions the chicks rapidly catch cold and die. On the other hand it is almost as bad to have the temperature too high, for in this case the vigor of the chicks will be reduced and they will be unprofitable. The heat should radiate from above down on the chickens' backs.

Where the chicks are to be raised on a large scale the brooder house heated by hot water pipes is the most economical, for in this case there is only one fire to attend, and the work of feeding and watering the chicks can be done much easier than when the chicks are scattered about in individual brooders. In fact, it has been my experience that outside brooders are not very satisfactory, for the work has to be done out of doors in all sorts of weather, making it disagreeable and costly to perform.

During the past year I have had some experience with the Petaluma system of brooding. According to this methed, no hovers are used. The chicks are placed on the floor of the brooder house surrounding the brooder stove which reflects heat down on their backs. From fifteen hundred to seventeen hundred chickens can be raised in one flock in this way. This method seems to be well adapted to raising chickens on a large scale, as the labor in caring for them is very materially reduced, and the chicks always have plenty of fresh air and grow up strong and vigorous.

Feeding. Next in importance to the temperature at which the little chicks are kept is the food which they receive. In the case of a chick, nature provides for its sustenance until it is able to run about and obtain food partly by its own efforts. The food material thus provided consists of the contents of the yolk sack which is slipped into the abdominal cavity a few hours before the chick is hatched. The yolk sack is connected with the intestine by a duct through which the semi-fluid mass passes into the digestive system where it is absorbed.

In feeding little chicks it should be clearly realized at the outset that they grow much more rapidly in respect to their original weight than any other of our common domesticated animals. Chicks when removed from the incubator weigh about one and one-half ounces each, and they can be made to weigh two and one-half pounds or forty ounces apiece when twelve weeks old. This is an increase of slightly more than twenty-six times the original weight in twelve weeks. In other words, during the first twelve weeks of its life a little

Col. R. M. Washington, a Well Known Poultryman of West Virginia. His Large Commercial Poultry Plant is Located Nearby.

chick averages to increase in weight each week more than double its original weight. Let us see what this means, taking for an example a young child. If a baby weighing ten pounds at birth were to grow relatively as fast as a chicken it would weigh about 260 pounds when twelve weeks of age! This extreme rapidity of growth in the case of a chicken requires liberal feeding, and I have never yet been able to understand why the advice is so frequently given not to overfeed little chickens, for if the chicks are healthy and are given an opportunity to take a normal amount of exercise they will not eat more than they can properly digest and assimilate. A baby under normal conditions doubles its original weight in about 180 days; a chick in about six days. In other words the processes of digestion and assimilation are about thirty times as active in the case of a chick as in a baby, and the amount of food required is about thirty times as great in proportion to the body weight Liberal feeding is the keynote of success in feeding little chicks. Feed them liberally from the start and keep them growing.

Before the chicks are removed from the incubator it is a good plan to cover the floor of the brooder with shreaded alfalfa or similar material to the depth of two or three inches. A good grade of chick feed should be added to this and the whole thoroughly mixed so that the pieces of grain are uniformly distributed throughout the mass. The chicks will soon begin to scratch in this litter, thus taking necessary exercise. Water should be provided from the start, and in addition to the chick feed in the litter, is is a good plan to feed a moistened mash once or twice a day. The mash may have the following composition: Equal parts of corn meal, wheat bran, and ground oats from which the coarser hulls have been removed and to which 10 or 15 per cent of good beef scrap has been added. If skim milk is available with which to moisten the mash it should be used, and in that event 10 per cent of beef scrap is sufficient. Only enough milk or water should be used to moisten the mash. It should not be sloppy. It should be fed only in such quantity that the chicks clean it up promptly, care being exercised to give the chicks sufficient trough room so that all may have an equal chance. After the chicks have become two or three weeks old cracked corn and wheat may be substituted gradually for the chick feed. When the chicks become old enough not to require artificial heat and are placed in colony houses and given free range it is a good plan to supply dry mash in hoppers and gradually cease from feeding the moistened mash. Milk is of great value in raising chicks as it supplies protein in a very digestible form and is rich in mineral elements.

I have also had excellent results in feeding little chicks according to the method advocated by the Maine Experiment Station. Briefly this method is as follows:

A mixture of three parts of corn meal, one part wheat bran, and one part wheat middlings or flour is used from which to make bread. This is mixed very stiff with skim milk or water and salted as usual for bread. It is baked in a slow oven, and when done the loaves are split open and returned to the oven where it remains until the bread is thoroughly dry. The crusts are then pounded until they are pulverized. The infertile eggs are hard boiled and ground shell and all in a sausage mill. One part ground egg and four parts bread crumbs are then mixed together and the mixture run through the sausage mill or food chopper.

The chicks are fed in the morning and at night on the bread and egg mixture, and during the middle of the day they scratch in the litter for the dry cracked grain or chick food which is provided for them. The egg mixture is used for about two weeks, and although it is expensive when infertile eggs are not available, yet it makes the chicks thrive wonderfully well. Grit and charcoal must be freely provided and after the chicks are a few days old green food in some form becomes a practical necessity. This is an excellent method, but is somewhat laborious when large numbers of chicks are raised.

Mineral Nutrients. In a preceding paragraph we have already seen that chicks grow relatively very rapidly. Now if we may judge by analogy the rapidity of growth and the demand for mineral nutrients are closely connected. It is true that we have little or no data available in regard to this matter with direct reference either to birds or the lower orders of organic life, but some very careful studies have been made with mammals, those animals which suckle their young, and it has been found that the more rapid the growth of the young the more ash constituents or inorganic matter is present in the mother's milk. This relationship is indicated in the following table taken from bulletin 201 of the Ohio Experiment Station:

SPECIES	Time in days for the new-born animal to double its weight	100 PARTS OF MILK CONTAIN			
		Protein	Ash	Calcium	Phosphorus
Man	180	1.6	0.2	.021	.022
Horse	60	2.0	0.4	.086	.057
Cow	47	3.5	0.7	.114	.087
Goat	22	3.7	0.78	.143	.122
Sheep ...	15	4.9	0.84	.178	.127
Swine	14	5.2	0.80	.178	.135
Cat	9.5	7.0	1.02	....	....
Dog	9	7.4	1.33	.321	.223
Rabbit ...	6	10.4	2.50	.636	.437

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It is to be observed that of the nine mammals mentioned, the young rabbit doubles its original weight in the shortest time, or in about six days. In this respect it stands next to a chicken, although the latter grows relatively faster. It is to be observed, also, that the more rapid the growth of the young, the more calcium and phosphorus there is in the milk, the phosphorus content of the rabbit's milk running up to .437 per cent.

Assuming that a rabbit and a chicken on account of the similarity in their rapidity of growth require practically the same amount of phosphorus, lime, etc, in their food, let us see how some of the feeding stuffs commonly used in feeding chickens compare in respect to the total ash constituents, phosphorus and lime with the amount of the same materials present in the milk of the rabbit. I have no figures showing the amount of solids in the milk of the rabbit, but assuming that there is double as much dry matter as in cow's milk, which must be approximately correct, then the dry substance of rabbit's milk would contain approximately 1.75 per cent phosphorus, 2.54 per cent calcium, and 10 per cent ash. Let us consider corn meal. In corn meal there is .13 per cent phosphorus, .03 per cent calcium and only .68 per cent ash. In the dry matter of rabbits' milk there is, then, more than ten times as much phosphorus, eighty times as much lime, and fifteen times as much total ash. In view of these facts, it is no wonder that corn meal when fed by itself is not a good food for growing chickens. Of course, if a chick fed on corn meal has access to an abundance of animal food, such as bugs and worms, cut bone, or beef scrap, all of which are rich in lime and phosphorus, then satisfactory gains can be made, as the materials of animal origin supply those ash constituents which are so decidedly deficient in corn meal.

Large Amount of Mineral Food Required.

It may be well to point out here that the requirements of a growing chick and a mature fowl differ somewhat in respect to mineral matter. A chick requires large amounts of lime and phosphorus or calcium phosphate, for the formation of bone and to enter into the composition of the tissues, while little of these materials are required by a mature fowl for mere maintenance. When fowls are laying, however, there is a demand for large quantities of lime used in building up the shell of the egg, and also for a smaller amount of phosphorus, as the yolk of an egg is a highly phosphorized substance.

The question now arises, can the ash constituents or inorganic substances which it is necessary to add to a grain

Putnam County, W. Va. Poultry Could be Raised Profitably in This Orchard in Large Numbers.

ration in order to make it a suitable food for growing chickens, be derived from any other source than materials of animal origin, such as beef scrap, granulated milk, or cut green bone. To answer this question we have very little or no data with direct reference to poultry, although some of the Experiment Stations are now at work on this problem, but some very interesting tests along this line have been reported recently by the Wisconsin Experiment Station in which young growing pigs were the animals experimented on. It was found that they have the power to make use of phosphorus and lime from inorganic sources, when the ration otherwise would be deficient in these constituents, so it appears highly probable that in raising chicks inorganic phosphates will be of great value especially when the ration is somewhat deficient in beef scrap, or other materials of animal origin, which are rich in phosphorus. For further discussion of this subject the reader is referred to Research Bulletin No. 1, Wisconsin Agricultural Experiment Station, Madison, Wisconsin.

Two Important Chick Diseases.

When chickens are raised in large numbers artificially, some of them are sure to die before they are more than a month old. If the number of deaths is excessive it is very important to determine the cause of the mortality. Frequently this can be determined by a simple post mortem examination.

Most young chicks die either through inflammation of the lungs or through non-absorption of the contents of the yolk sack or white diarrhoea.

Inflammation of the Lungs. In health the lungs of a chick are of a porous spongy nature, and bright scarlet in color. If the chick has caught cold and died from that cause the lungs, or at least portions of them, are apt to be soggy in texture and dark red in color. If the inflammation has continued for some days before the death of the chick, there are usually little lightish colored nodules filled with cheesy matter scattered through the lung tissue. For this condition of the lungs there is no remedy. Prevention is better than a cure.

Non-absorption of the Contents of the Yolk Sack or White Diarrhoea. Kill and examine two or three healthy chicks of the same age as those that die and compare the condition of the yolk sacks in the two cases. If the contents of the yolk sack is abnormal, being either too full of fluid matter in the case of very young chicks, or containing a considerable amount of cheesy substance in those that are older, and if the intestines, to a considerable extent, are empty, or distended with gas, together with general diarrhoeal conditions, it is probable that bacillary white diarrhoea is present. To determine the matter definitely requires a bacteriological examination.

White diarrhoea is a germ disease and seems to be transmitted to the chick through the egg, by infected breeding stock. The infected chicks, too, can spread the disease by means of bacteria present in their droppings. These may be taken into the digestive system of healthy chicks, thus spreading the infection. Chickens more than three or four days old, however, do not contract the disease in this way, so if a chick is hatched free from the disease and is kept from contracting it for three or four days it probably will remain healthy.

So far no remedy has been proposed. Preventive measure, however, are of value, and the following suggestions have been offered by the Connecticut Experiment Station, where this disease has been studied:

"**Prevention** Since the disease cannot, apparently, be transmitted through the food supply after the chicks have reached the age of three or four days, every means should be pursued to prevent the spread of the infection during this critical period. We suggest:

The segregation of the chicks in small lots during this interval.

Perfect disinfection and cleanliness of brooders or brood coops.

Food and water supplied in such a manner as to prevent contamination by the droppings.

The use in the brooder of a liberal amount of fine, absorptive litter which will quickly cover and seal up the droppings.*

Raise and maintain the vigor and vitality of the breeding stock and chicks by every reasonable means known to the poultryman."

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*For this purpose we have used alfalfa meal with much satisfaction.